FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Midwest Geological Sequestration Consortium
Contacts: DOE/NETL Project Mgr.	Name Organization E-Mail John Litynski NETL John.Litynski@netl.doe.gov
Principal Investigator	Robert J. Finley Illinois State Geological Survey finley@isgs.uiuc.edu
Field Test Information: Field Test Name	Task 12: Deep Saline Reservoir
Test Location	Decatur, Illinois
Amount and Source of CO_2	Tons Source: 1,000,000 Archer Daniels Midland, Company (ADM) (ethanol plant)
Field Test Partners (Primary Sponsors)	ADM

Summary of Field Test Site and Operations:

The thickest and most widespread saline reservoir in the Illinois Basin is the Cambrian-age Mt. Simon Sandstone. It is overlain by the Eau Claire Formation, a regional, non-permeable shale and underlain by Precambrian granitic basement. Gas storage projects in the Illinois Basin all confirm that the Eau Claire is an effective seal in the northern and central portions of the Basin.

The site for the deep saline project has been selected and the scope of the Deep Saline Pilot has been amended to demonstrate the ability of the Mt. Simon Sandstone, a major regional saline-water bearing formation in the Illinois Basin, to accept and retain 1 million tons of carbon dioxide injected over a period of three years. The proposed site is on the property of Archer Daniels Midland (ADM) Company in Decatur, Illinois, and the proposed CO_2 source is ADM's ethanol fermentation operation at their Decatur facility. The CO2 injection well is scheduled to be drilled in April - May 2008. A detailed pre-injection site assessment and drilling of the injection well will take place under the saline reservoir task of the current Phase II effort to characterize the site and ensure its suitability. Expanded Phase III activities will overlap the Phase II effort to make the site suitable for a large-scale injection test. Linking Phase II and proposed Phase III tasks will reduce costs and test large-scale sequestration sooner than might otherwise be possible. This is an important objective given the increased costs for steel pipe, drilling, well logging, and other oil field services that have occurred since Phase II was proposed. The MGSC initially characterized the site using orthogonal 2D seismic lines to confirm the geological structure at the site and to test for any seismically resolvable faults that may exist. Preliminary interpretation has shown no such faults. A well will then be drilled through the entire Mt. Simon Sandstone to the underlying granitic basement and will include extensive logging, core sampling, and fluid sampling to build a comprehensive reservoir model at the site. This model will be used to approximate the distribution of the injected CO_2 and of the potential reactivity of the CO_2 and CO_2-laden brine with the reservoir and the seals. The model will be expanded as more data are derived from a baseline 3D seismic survey and will be used to predict where additional geophysical surveys will be deployed as CO_2 is injected. Injection at a nominal daily rate of 1,000 tons per day will begin in October 2009. One of the injection zone targets is expected to be near the base of the Mt. Simon Sandstone based on regional geology and will be defined based on well logs and core samples taken from the initial well drilled on the site.

Research Objectives:

The goal is to demonstrate that geologic sequestration is a safe and permanent method to mitigate GHG emissions. Deep, saline water-bearing reservoirs offer the greatest potential for sequestration of large volumes of CO_2. This saline reservoir injection will evaluate the potential of sequestering CO_2 in deep saline reservoirs which have no producible resources with economic value. The Mt. Simon was selected as the optimum saline sink because of its widespread nature; it is present in the subsurface of many of the Midwestern states. We will be monitoring the effectiveness of the sequestration with an extensive MMV program.

Summary of Modeling and MMV Efforts: (Use the table provided for MMV)

- ***Geophysical methods*:**

High Resolution Electrical Earth Resistivity **(HREER)** will be used to measure resistivity in the relatively shallow geologic environment to indicate changes in soil moisture that maybe caused by migrating CO_2. A permanent resistivity grid located near the injection well will allow earth resistivity measurements to be collected continually prior to, during, and after CO_2 injection. To track CO_2 in and above storage formation time-lapse seismic imaging would be applied as pre-, during, and post-injection surveys. Also, to determine the development of any micro fractures in the injection formation or cap rock, rock which could provide pathways for CO_2 migration, passive seismic (micro seismic) monitoring in or near the injection well could be run during, and post-injection. Vertical Seismic **(VSP)** profiles will be run at the deep saline reservoir site during and-post-injection as a monitoring approach to define the plume margin in comparison to the pre-injection 3-D seismic survey.

- ***Geochemical methods:***

Monitoring the changes in major and trace constituents as well as pH, alkalinity, stable and radioactive isotopes, gases, and chemical composition of ground water will be used to monitor for any impacts of CO_2 migration. In addition, chemical tracers (PFCs) will be added to the CO_2 injection stream to assist in source tracking of CO_2.

- ***Soil gas sampling:***

Concentrations of CO_2 and light hydrocarbons (C1-C6) will be measured in the vadose zone pre-injection, during injection, and post-injection to detect any elevated levels of CO_2, identify source of elevated soil gas, and evaluate ecosystem impacts.

- ***CO_2 land surface flux monitoring:***

CO_2 surface fluxes using accumulation chambers and CO_2 fluxes in the atmosphere using Eddy Covariance will be monitored at the deep saline site pre-injection, during injection, and post-injection.

- ***Visible and infrared imaging:***

Digital Color Infrared Orthoimagery **(CIR)** acquired by satellite may be used to indicate if the cell structure of -the local vegetation is affected by an outside stressor, such as seepage of CO_2 into the biosphere. This technique provides a large spatial coverage of our study site with the resulting data assisting in validation of the integrity of the seal formation, injection well, and other potential migration pathways to the biosphere pre-injection, during injection, and post-injection.

- ***Well Logging:***

Well logs are the best tools to validate the integrity of the injection well, monitor the storage formation and seal, and measure seismic velocities, water saturation, gas content, salinity, and hydrocarbon content around the well casing. Multiple well logging methods will be run, such as: gamma ray log, resistivity, Ultra Sonic Instrument **(USI)**, density, neutron, formation micro imagery, and Reservoir Saturation Tool **(RST)** several of which are to be run pre- and post-injection.

- ***Ground water monitoring:***

Ground water monitoring will be used pre-injection, during injection, and post-injection to measure quality and flow direction in shallow ground water and to monitor any changes in water quality after CO_2 injection to validate integrity of seal formation, injection well, and other potential migration pathways to the biosphere.

- ***Subsurface pressure and temperature, gas content and fluid chemistry:***

Gas content, fluid chemistry, and pressure of formation and temperature at the wellhead, and in the annulus zone will be monitored to determine reactions of injected CO_2 to the formation matrix fluid, provide level of safety to operators, and to insure integrity of formation and seal (pre-, during, and post-injection). Two validation wells drilled subsequent to the injection well will be key sources of these data.

- ***Measuring CO_2 injection rate, Volume, and isotopic composition:***

To validate the volume of CO_2 injected into the formation, the injection rate will be monitored during injection. Isotopic composition of CO_2 will be used to trace any CO_2 migration and to validate injection well and formation integrity. Tracers may be used in addition to these methods.

- ***Groundwater and Geochemical Modeling:***

Atmospheric, geochemical, and groundwater flow models will be used to help validate the integrity of the injection formation and cap rock. Modeling results will be compared to data collected at the site. Atmospheric models will estimate the dispersion and concentrations of CO_2 into the air from the local industrial sources and potential leakage from the injection formation. Models such as **TOUGH2** coupled with **LSM** (land-surface model) will estimate the potential migration of CO_2 in the unsaturated zone and the near-surface environment in addition to atmospheric releases. Groundwater models such as **MODFLOW** and **GFLOW** will be used to develop a conceptual model for shallow groundwater flow and estimate the time for potential contaminants to travel outside the area of the injection site. Results from this modeling effort will provide an estimate of any risk to nearby water supplies, should CO_2 leakage occur during or post-injection. Geochemical models such as **Geochemist's workbench**, **PHREEQCI,** and **TOUGHREACT** would be applied for thermodynamic modeling of shallow groundwater and injection-formation brine to determine the potential effects of CO_2 on the solution equilibria of groundwater and to predict the extent of mineral trapping of carbon dioxide. These models will provide insights on the long-term fate of injected CO_2 and will be used to study the regional impact of multiple injection wells on flow within a saline aquifer across the Illinois Basin.

Reactive transport and geochemical modeling of the fate of injected carbon dioxide and its effects on the chemical and mineralogical composition of the injection formation and confining layers with by studied using **NUFT** (non-isothermal/thermal, unsaturated/saturated, flow and transport model). The geomechanical model **LDEC** (distinct-element geomechanical model) will be used in conjunction with NUFT to predict pressure-stress relationships. LDEC will be applied to assess cap rock geomechanical deformation by simulating the evolution of microfactures created by the pressure of injected carbon dioxide.

Accomplishments to Date:

The site for the deep saline project has been selected and the scope of the Deep Saline Pilot has been amended to demonstrate the ability of the Mt. Simon Sandstone to accept and retain 1 million tons of carbon dioxide injected over a period of three years. An industrial partner has been confirmed and the proposed site is on the property of Archer Daniels Midland (ADM) Company in Decatur, Illinois, and the proposed CO_2 source is ADM's ethanol fermentation operation at their Decatur facility. Two-dimensional seismic was collected in October 2007 and is currently being analyzed. The UIC permit application for this well is underway and due to be submitted on schedule in December 2007. This well is scheduled to be drilled in April 2008.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

The Mt. Simon was selected as the optimum saline sink because of its widespread nature and immediately overlying Eau Claire shale seal. The Mt. Simon underlies one of the largest concentrations of coal fired power plants in the world. This makes the Mt. Simon one of the most significant carbon storage resources in the United States.

Cost:

Total Field Project Cost:
$4,425,178

(budget for oil & gas operator)

DOE Share: $ 3,929,010
89%

Non-Doe Share: $ 496,168
11%

Field Project Key Dates:

Baseline Completed: Sept 2006

Drilling Operations Begin: Oct 2007

Injection Operations Begin: Sept 2008

MMV Events: Oct-Nov 2006